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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/775,145	02/11/2004	Toshihiro Hayami	033082M194	2438

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EXAMINER	
ARANCIBIA, MAUREEN GRAMAGLIA	
ART UNIT	**PAPER NUMBER**
1792	

MAIL DATE	DELIVERY MODE
11/16/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/775,145	HAYAMI ET AL.	
	Examiner	Art Unit	
	Maureen G. Arancibia	1792	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *30 August 2007*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-9,11,12 and 14-24* is/are pending in the application.

4a) Of the above claim(s) *2 and 12* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,3-9,11 and 14-24* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *02 November 2006* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 30 August 2007 has been entered.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

3. Claims 1, 6, 8, and 9 are rejected under 35 U.S.C. 102(b) as being anticipated by U.S. Patent Application Publication 2003/0056901 to Nakano et al.

In regards to Claims 1 and 8, Nakano et al. teaches a plasma processing unit comprising: a processing container 10 whose pressure can be reduced by a pump (Paragraph 458); first and second electrodes 8, 4 arranged in the processing container; a process gas supplying unit 17 that supplies a process gas into the processing container; a tubular supporting part 12B that supports the first electrode 8 as broadly recited in the claims, the tubular supporting part forming a space together with a bottom surface of the first electrode 8 such that said space is disposed within the tubular

supporting part 12B below the first electrode 8, and a high-frequency electric power supplying part (shaft 13) at least partially arranged in the space, as broadly recited in the claims. The high-frequency electric power supplying part further includes a first high-frequency electric power source 27 that outputs first high-frequency electric power having a first frequency; a first matching unit 26 for impedance matching of the first frequency; and a transmission line 27A that transmits the first high-frequency electric power from the source to the matching unit. (Figure 17) The first high-frequency electric power transmitted to the first electrode is adapted to generate plasma in such a manner that the substrate 16 to be processed can undergo a plasma process by means of the plasma. (Paragraph 325)

In regards to Claim 6, Nakano et al. teaches that the transmission line 27A consists of a coaxial cable. (Paragraph 323)

In regards to Claim 9, Nakano et al. teaches that vent holes 7 are provided in the second electrode 4 to jet out the process gas towards the first electrode 8 holding the substrate 16 to be processed. (Figure 17)

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claims 3, 11, and 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nakano et al. in view of U.S. Patent 5,643,364 to Zhao et al.

The teachings of Nakano et al. were discussed above.

In regards to Claims 3 and 11, Nakano et al. does not teach that the length of the transmission line is shorter than $3\lambda/4$, λ being a wavelength of the third harmonic wave of the high-frequency electric power, and with respect to the third harmonic wave of the high-frequency power, an output terminal of the high-frequency electric power source is an electrically short-circuited end and an input terminal of the matching unit is an electrically open end.

Zhao et al. teaches a plasma processing unit (Figure 2), wherein a transmission line that transmits high-frequency power from high-frequency power generator 12" to processing container 10 is less than one eighth of the wavelength of the high-frequency power signal in length. (Column 3, Line 61 - Column 4, Line 6). Zhao et al. further teaches that when the transmission line is short compared to one quarter of the wavelength of the high-frequency power signal, the matching unit can be connected at either end of the transmission line; i.e. the transmission line in question can run from the high-frequency power generator to the matching unit, or from the matching unit, as part of the high-frequency power generator, to the processing container. (Column 2, Lines 40-44) An output terminal of the high-frequency power source 12 is an electrically short-circuited end and an input terminal of the matching unit 30 is an electrically open end. (Figure 2)

It would have been obvious to one of ordinary skill in the art to modify the apparatus taught by Nakano et al. to have the length of the transmission line between the power source and the matching unit be less than one eighth of the wavelength of

the high-frequency power signal, and to have an output terminal of the high-frequency power source be an electrically short-circuited end and an input terminal of the matching unit be an electrically open end. The motivation for having the length of the transmission line be less than one eighth of the wavelength of the high-frequency power signal, as taught by Zhao et al. (Column 4, Lines 3-11), would have been to allow for the substitution of a relatively inexpensive, compact, reliable fixed matching unit for the conventional variable matching unit, which can be more expensive and less reliable. The motivation to have an output terminal of the high-frequency power source be an electrically short-circuited end and an input terminal of the matching unit be an electrically open end, as taught by Zhao et al. (Column 4, Line 63 - Column 5, Line 9), would have been to allow for the inclusion of comparator circuitry to adjust delivered power as measured at the electrically open end of the matching unit by comparison with a desired power 38, which is illustrated in Figure 2 to be set relative to ground (electrically short circuited end).

Setting the length of the transmission line to be less than one eighth of the wavelength of the high-frequency power signal translates to the length being less than $3\lambda/8$, λ being a wavelength of the third harmonic wave of the high-frequency electric power. (The frequency of the third harmonic is three times the frequency of the applied high-frequency power signal, and thus the wavelength of the third harmonic is also three times the wavelength of the applied power signal.) Having the length of the transmission line be less than $3\lambda/8$ meets the limitation that it be less than $3\lambda/4$ (a length

where a resonance state of a third harmonic wave of the high-frequency electric power may be generated).

In regards to Claim 17, Nakano et al. teaches that the transmission line 27A consists of a coaxial cable. (Paragraph 323)

6. Claims 4, 5, and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nakano et al. in view of U.S. Patent 6,887,339 to Goodman et al. and U.S. Patent 6,703,080 to Reyzelman et al.

The teachings of Nakano et al. were discussed above.

In regards to Claim 4, Nakano et al. does not expressly teach that the high-frequency power generating part generates high-frequency power when DC power is supplied to it, or that the DC power source converts commercial AC power to generate the DC power.

Goodman et al. teaches that a DC power source 114 converts commercial AC power (*line voltage power supply*) to DC power, and supplies the DC power to a high-frequency generating part (*convertor 122*) via a cable. The high-frequency generating part then generates the high-frequency power. (Figure 7; Column 10, Lines 19-42)

It would have been obvious to one of ordinary skill in the art to modify the apparatus of Nakano et al. to have the high-frequency power generating part generate high-frequency power when DC power is supplied to it, and to have a DC power source that converts commercial AC power to generate the DC power. The motivation for making these modifications, as taught by Goodman et al. (Column 10, Lines 39-42),

would have been that such an arrangement, among other benefits, allows the high-frequency power to be controlled by varying the voltage on the DC converter.

In regards to Claims 4, 5, and 19, the combination of Nakano et al. and Goodman et al. does not expressly teach a filter, having an output terminal connected to the transmission line as an electrically short-circuited end, that selectively allows the high-frequency electric power from the high-frequency power generating part to pass through; or a circulator, connected between the high-frequency generating part and the filter, that allows a forward wave from the high-frequency power generating part to pass through and absorbs a reflected wave from the matching unit.

Reyzelman et al. teaches that a high-frequency power source 14 includes a filter (diplexer comprising low pass filter 52 and high pass filter 58) connected to the transmission line as an electrically short-circuited end (Figure 3B), that selectively allows the high-frequency electric power from the high-frequency power generating part to pass through; and a circulator 32, connected between the high-frequency generating part and the filter, that allows a forward wave from the high-frequency power generating part (power indicated at 28) to pass through and absorbs a reflected wave from the matching unit 60. (Figure 3B; Column 7, Lines 13-21; Column 9, Lines 3-30)

It would have been obvious to one of ordinary skill in the art to modify the combination of Nakano et al. and Goodman et al. to include a filter and a circulator in the manner taught by Reyzelman et al. The motivation, as taught by Reyzelman et al. (Column 9, Lines 31-34) for including a filter in the manner taught by Reyzelman et al., would have been to decrease the amplitude of reverse signals coming back from the

plasma load through the matching unit and reaching the high-frequency power generating part. The motivation, as taught by Reyzelman et al. (Column 13, Line 55 Column 14, Line 3) for including a circulator in the manner taught by Reyzelman et al., would have been to provide isolation and suppression of reflected power caused by interactive plasma impedances that would otherwise degrade stability and reliability of the system.

7. Claim 7 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nakano et al. in view of Reyzelman et al.

The teachings of Nakano et al. were discussed above.

In regards to Claim 7, Nakano et al. does not expressly teach that the first frequency is 70 MHz or greater.

Reyzelman et al. teaches the use in plasma processing systems of very high frequency (VHF) power generators, with frequencies of 40-300 MHz (which range overlaps with the claimed range). (Column 1, Lines 50-61)

It would have been obvious to one of ordinary skill in the art to modify the teachings of Nakano et al. in view of the teachings of Reyzelman et al. to use a VHF power generator to supply the first power to the first electrode. The motivation for making such a modification, as taught by Reyzelman et al. (Column 1, Lines 50-61), would have been to obtain better uniformity of ion and radical flux across the wafer, higher productivity, and higher repeatability.

8. Claim 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nakano et al. in view of Zhao et al. as applied to Claim 11 above, and further in view of Reyzelman et al.

The teachings of Nakano et al. and Zhao et al. were discussed above.

In regards to Claim 7, the combination of Nakano et al. and Zhao et al. does not expressly teach that the first frequency is 70 MHz or greater.

Reyzelman et al. teaches the use in plasma processing systems of very high frequency (VHF) power generators, with frequencies of 40-300 MHz (which range overlaps with the claimed range). (Column 1, Lines 50-61)

It would have been obvious to one of ordinary skill in the art to modify the teachings of Nakano et al. and Zhao et al. in view of the teachings of Reyzelman et al. to use a VHF power generator to supply the first power to the first electrode. The motivation for making such a modification, as taught by Reyzelman et al. (Column 1, Lines 50-61), would have been to obtain better uniformity of ion and radical flux across the wafer, higher productivity, and higher repeatability.

9. Claims 14-16 and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nakano et al. in view of Zhao et al. as applied to Claim 11, and further in view of Goodman et al. and Reyzelman et al.

The teachings of Nakano et al. and Zhao et al. were discussed above in regards to Claim 11.

In regards to Claims 14 and 16, the combination of Nakano et al. and Zhao et al. does not expressly teach that the high-frequency power generating part generates high-

frequency power when DC power is supplied to it, or that the DC power source converts commercial AC power to generate the DC power.

Goodman et al. teaches that a DC power source 114 converts commercial AC power (*line voltage power supply*) to DC power, and supplies the DC power to a high-frequency generating part (*convertor 122*) via a cable. The high-frequency generating part then generates the high-frequency power. (Figure 7; Column 10, Lines 19-42)

It would have been obvious to one of ordinary skill in the art to modify the apparatus of Nakano et al. and Zhao et al. to have the high-frequency power generating part generate high-frequency power when DC power is supplied to it, and to have a DC power source that converts commercial AC power to generate the DC power. The motivation for making these modifications, as taught by Goodman et al. (Column 10, Lines 39-42), would have been that such an arrangement, among other benefits, allows the high-frequency power to be controlled by varying the voltage on the DC converter.

In regards to Claims 14-16 and 22, the combination of Nakano et al., Zhao et al., and Goodman et al. does not expressly teach a filter, having an output terminal connected to the transmission line as an electrically short-circuited end, that selectively allows the high-frequency electric power from the high-frequency power generating part to pass through; or a circulator, connected between the high-frequency generating part and the filter, that allows a forward wave from the high-frequency power generating part to pass through and absorbs a reflected wave from the matching unit.

Reyzelman et al. teaches that a high-frequency power source 14 includes a filter (diplexer comprising low pass filter 52 and high pass filter 58) connected to the

transmission line as an electrically short-circuited end (Figure 3B), that selectively allows the high-frequency electric power from the high-frequency power generating part to pass through; and a circulator 32, connected between the high-frequency generating part and the filter, that allows a forward wave from the high-frequency power generating part (power indicated at 28) to pass through and absorbs a reflected wave from the matching unit 60. (Figure 3B; Column 7, Lines 13-21; Column 9, Lines 3-30)

It would have been obvious to one of ordinary skill in the art to modify the combination of Nakano et al., Zhao et al., and Goodman et al. to include a filter and a circulator in the manner taught by Reyzelman et al. The motivation, as taught by Reyzelman et al. (Column 9, Lines 31-34) for including a filter in the manner taught by Reyzelman et al., would have been to decrease the amplitude of reverse signals coming back from the plasma load through the matching unit and reaching the high-frequency power generating part. The motivation, as taught by Reyzelman et al. (Column 13, Line 55 Column 14, Line 3) for including a circulator in the manner taught by Reyzelman et al., would have been to provide isolation and suppression of reflected power caused by interactive plasma impedances that would otherwise degrade stability and reliability of the system.

10. Claim 20 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nakano et al. in view of U.S. Patent 6,089,181 to Suemasa et al.

The teachings of Nakano et al. were discussed above.

Nakano et al. does not expressly teach a second high frequency electric power source and second matching unit for supplying a second electric power to the first electrode.

Suemasa et al. teaches first and second high frequency power sources 140, 148 are connected to a first electrode via first and second matching units 144, 156, respectively, for supplying two electric powers to the first electrode. (Figure 1)

It would have been obvious to one of ordinary skill in the art to modify the apparatus taught by Nakano et al. to include a second high frequency power source and a second matching unit connected to the first electrode, as taught by Suemasa et al. The motivation for doing so, as taught by Suemasa et al. (Column 5, Line 63 - Column 6, Line 57), would have been to supply a superposed RF power to the first electrode, thereby improving plasma etching uniformity and rate.

11. Claim 23 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nakano et al. in view of Zhao et al. as applied to Claim 11 above, and further in view of Suemasa et al.

The teachings of Nakano et al. and Zhao et al. were discussed above.

The combination of Nakano et al. and Zhao et al. does not expressly teach a second high frequency electric power source and second matching unit for supplying a second electric power to the first electrode.

Suemasa et al. teaches first and second high frequency power sources 140, 148 are connected to a first electrode via first and second matching units 144, 156, respectively, for supplying two electric powers to the first electrode. (Figure 1)

It would have been obvious to one of ordinary skill in the art to modify the apparatus taught by Nakano et al. and Zhao et al. to include a second high frequency power source and a second matching unit connected to the first electrode, as taught by Suemasa et al. The motivation for doing so, as taught by Suemasa et al. (Column 5, Line 63 - Column 6, Line 57), would have been to supply a superposed RF power to the first electrode, thereby improving plasma etching uniformity and rate.

12. Claim 21 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nakano et al. in view of Suemasa et al. as applied to claim 20 above, and further in view of U.S. Patent 6,242,360 to Fischer et al.

The teachings of Nakano et al. and Suemasa et al. were discussed above.

The combination of Nakano et al. and Suemasa et al. does not expressly teach that the high-frequency electric power supplying part comprises three vertically stacked boxes, and the first high-frequency electric power source, the first matching unit, and the second matching unit are contained in the three boxes.

Fischer et al. teaches that a high-frequency electric power supplying part 300 comprises three stacked boxes 324, 308, 310, and that a high-frequency electric power source 310 and a matching unit 328 are contained in separate boxes. (Figures 3 and 4)

It would have been obvious to one of ordinary skill in the art, in view of the teachings of Fischer et al., to modify the apparatus taught by Nakano et al. and Suemasa et al. to provide at least three stacked boxes to separately contain each of the first high-frequency electric power source, the first matching unit, and the second matching unit. The motivation for doing so, as taught by Fischer et al. (Column 4, Lines

49-60), would have been to ensure a single RF current return path to the high-frequency electric power source and to eliminate stray return currents by isolating the body of each RF matching network from the chassis of the RF shield box.

Whether the boxes are stacked "horizontally" or "vertically" is a matter of the frame of reference from which the apparatus taught by the combination of Nakano et al., Suemasa et al., and Fischer et al. is observed, and is not considered to be a patentably distinct *structural difference* between the claimed invention and that taught by the cited prior art.

13. Claim 24 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nakano et al. in view of Zhao et al., and further in view of Suemasa et al. as applied to claim 20 above, and further in view of Fischer et al.

The teachings of Nakano et al., Zhao et al., and Suemasa et al. were discussed above.

The combination of Nakano et al., Zhao et al., and Suemasa et al. does not expressly teach that the high-frequency electric power supplying part comprises three vertically stacked boxes, and the first high-frequency electric power source, the first matching unit, and the second matching unit are contained in the three boxes.

Fischer et al. teaches that a high-frequency electric power supplying part 300 comprises three stacked boxes 324, 308, 310, and that a high-frequency electric power source 310 and a matching unit 328 are contained in separate boxes. (Figures 3 and 4)

It would have been obvious to one of ordinary skill in the art, in view of the teachings of Fischer et al., to modify the apparatus taught by Nakano et al., Zhao et al.,

and Suemasa et al. to provide at least three stacked boxes to separately contain each of the first high-frequency electric power source, the first matching unit, and the second matching unit. The motivation for doing so, as taught by Fischer et al. (Column 4, Lines 49-60), would have been to ensure a single RF current return path to the high-frequency electric power source and to eliminate stray return currents by isolating the body of each RF matching network from the chassis of the RF shield box.

Whether the boxes are stacked "horizontally" or "vertically" is a matter of the frame of reference from which the apparatus taught by the combination of Nakano et al., Zhao et al., Suemasa et al., and Fischer et al. is observed, and is not considered to be a patentably distinct *structural difference* between the claimed invention and that taught by the cited prior art.

Response to Arguments

14. Applicant's arguments with respect to the pending claims have been considered but are moot in view of the new ground(s) of rejection necessitated by the amendment to the claims.

Conclusion

15. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Maureen G. Arancibia whose telephone number is (571) 272-1219. The examiner can normally be reached on core hours of 10-5, Monday-Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Parviz Hassanzadeh can be reached on (571) 272-1435. The fax phone

number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

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